APPENDIX: Geotechnical Engineering Report

GeoSource

Your Source for Geotechnical and Materials Engineering

February 24, 2010

Mr. Mike Butler, PE
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1125 Garden Way
Manhattan, Kansas 66502-1740

Subject: **Geotechnical Engineering Report**
Proposed Equestrian Campground
Sand Hills State Park, 4207 E. 56th Avenue
Hutchinson, Kansas
Project No. D10G0332

Dear Mike:

We have completed the subsurface exploration and geotechnical engineering evaluation for the above referenced project. The purpose of the exploration was to obtain information on the subsurface conditions within the proposed building and pavement areas and, based on this information to provide geotechnical engineering recommendations for design and construction for the proposed structures and pavements.

In summary, the borings encountered wind deposited dune sands that continued to the depths explored. These soils were generally comprised of loose fine sands and/or sandy silts. Recommendations for design and construction of the building foundations and paved roadways and parking areas are presented in the following report.

This report completes our current scope of services for this project. The enclosed report describes our exploration procedures and presents the results of the testing and evaluation along with design and construction recommendations for this project. We appreciate the opportunity to work with you on this project and are prepared to provide the recommended construction services.

Respectfully submitted,

GeoSource, LLC

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PROPOSED EQUESTRIAN CAMPGROUND
SAND HILLS STATE PARK
HUTCHINSON, KANSAS

Project No. D10G0332
February 24, 2010

INTRODUCTION

GeoSource has completed the subsurface exploration and geotechnical engineering evaluation for the proposed Equestrian Campground structures and pavements that are planned at the Sand Hills State Park, located at 4207 E, 56th Avenue in Hutchinson, Kansas. Our services for this project were provided in general accordance with our January 14, 2010 proposal. Mr. Mike Butler with Schwab-Eaton authorized the exploration work on January 25, 2010 by signing our proposal/contract.

PROJECT DESCRIPTION

We understand that the Kansas Department of Wildlife & Parks plans to construct a new Equestrian Campground at the Sand Hills State Park near Hutchinson, Kansas. We understand that the proposed project will consist of approximately 2,850 ± lineal feet of asphalt paved roadway (ring road) around the pond, with gravel surfaced campground parking on either side of the ring road. The grade around the top of the ring road is currently at about elevation 1586 ± feet and the campsite parking areas on either side of the ring road will slope downward at a grade of about 2 percent away from the ring road. It is understood that the water level in the existing pond was at about elevation 1576 ± feet at the time the site survey was conducted. It is understood that preliminary site grading work for the ring road was completed about 2 years ago by Wildlife & Parks personnel when the existing pond was excavated. The survey performed by Schwab-Eaton indicated that about 2 to 3 feet of fill was placed for the ring road at that time. It is understood that no compaction testing was performed during the fill placement operation.

Traffic on the ring road is expected to consist of automobiles, recreational vehicles and/or light pick-up trucks and horse trailers. Final grade modifications for the proposed ring road and campsite parking areas are expect to be relatively minor, requiring less than 3 feet of additional cut and/or fill to develop final grades. No other specific information was known at the time our proposal was prepared.

In addition, a new shop building is planned near the entrance to the park. No information was known about the new shop building at the time our report was prepared. We have assumed that the shop building will be a single story, pre-engineered metal building with a grade supported floor slab. Foundation loads for the shop building were assumed to be less than 50 kips for columns and 3 kips per lineal foot for load bearing walls. We have also assumed that the finished floor elevation of the new shop building will approximately match the existing site grades, requiring less than 3 feet of new fill for site development.

The scope of the exploration and engineering evaluation for this study, as well as the conclusions and recommendations in this report, were based on our understanding of the project as described above. If pertinent details of the project have changed or otherwise differ from our descriptions, GeoSource should be notified and engaged to review the changes and to modify our recommendations, if needed.

DRILLING AND SAMPLING PROCEDURES

The field work was performed on February 12, 2010. A total of six exploratory test borings were drilled at the approximate locations shown on Figure 1, which is included in Appendix A of this report. The boring locations were staked by Schwab-Eaton personnel, prior to the start of the field work. The ground surface elevations shown on the boring logs were also determined by Schwab-Eaton.

The borings were performed with a CME-45 rotary drill rig mounted on an all-terrain carrier. The borehole was advanced with 4-inch diameter continuous flight augers. Representative samples of the onsite soils were obtained at selected intervals using the split-barrel sampling procedure in accordance with ASTM Specification D-1586. The split-barrel sampling procedure utilizes a standard 2-inch O.D. split-barrel sampler that is driven into the bottom of the boring with an automatic hammer. The number of blows required to advance the sampler the last 12 inches of a normal 18-inch penetration is recorded as the Standard Penetration Resistance Value (N). These "N" values are indicated on the boring logs at their depth of occurrence and provide an indication of the consistency of clays and the relative density of sands and sandy soils. A higher efficiency is achieved with the automatic hammer compared to the conventional safety hammer operated with a cathead and rope. This higher efficiency has an appreciable effect on the Standard Penetration Resistance Values (N). The effect of the automatic hammer's efficiency has been considered in the interpretation and analysis of the subsurface information for this report. The samples were sealed and returned to our laboratory for further examination, classification and testing.

Boring logs are included in Appendix A of this report and present such data as soil descriptions, consistency and relative density evaluations, depths, sampling intervals and observed groundwater conditions. Conditions encountered in each of the borings were monitored and recorded by the drill crew. Field logs included visual classification of the materials encountered during drilling, as well as drilling characteristics. Our final boring logs represent the engineer's interpretation of the field logs combined with laboratory observation and testing of the samples. Stratification boundaries indicated on the boring logs were based on observations during our field work, an extrapolation of information obtained by examining samples from the borings and comparisons of soils types with similar engineering characteristics. Locations of these boundaries are approximate, and the transitions between soil and bedrock types may be more gradational in nature rather than clearly defined.

LABORATORY TESTING PROGRAM

Laboratory tests were performed on representative samples of the onsite soils to evaluate pertinent engineering properties of these materials. The laboratory tests were performed in general accordance with ASTM and/or other applicable standards. Moisture content determinations were performed on samples obtained with the split-barrel sampler. The results of these tests are shown on the individual boring logs in Appendix A of this report.

In addition, Atterberg Limits, grain size analysis, Standard Proctor and California Bearing Ratio (CBR) tests were performed on selected samples. Atterberg Limits and grain size tests provide information on the plasticity and particle size distribution of the soils, which is a basis for classification. The Standard Proctor test is used to determine the moisture-density relationship of the soil, and is used to evaluate the degree of compaction of the soil placed during construction. The CBR value is used in the design of flexible pavements and has been correlated with other tests that allow us to determine a modulus of subgrade reaction which is used in the design of rigid pavement sections. The results of the Atterberg Limits tests are shown on the individual boring logs in Appendix A and the results of other tests are presented on grain size curves and summary test reports in Appendix B.

As part of the testing program, the soil samples were classified by a geotechnical engineer using visual and manual procedures outlined in ASTM D-2487 and D-2488. The descriptions of the soils indicated on the boring logs are in accordance with the enclosed General Notes and the Unified Soil Classification System. Estimated group symbols according to the Unified Soil Classification System are shown on the boring logs. A brief description of this classification system is included in the Appendix of this report.

PHYSIOGRAPHY AND REGIONAL GEOLOGY

Sand Hills State Park is located in the Arkansas River Lowlands Physiographic Region of Kansas. The Arkansas River Lowlands physiographic region typically consists of relatively flat alluvial plains. The soils within this region generally consist of wind deposited loess and anchored sand dunes along the flanks of the Arkansas River Valley, with alluvial soils within the river valleys that were deposited by the Arkansas River or one of its tributaries during the past 10 million years as the river flowed through

Kansas from its source in the Rocky Mountains. The term anchored sand dune refers to dunes that are covered with vegetation and no longer actively moving.

The bedrock units that underlie the wind deposited soils and alluvium are part of the Wellington Formation of the Permian Age Sumner Group. The Wellington Formation is comprised predominately of shales with minor amounts of limestone, dolomite, siltstone, gypsum and anhydrite. The formation includes both marine and fresh water deposits, and contains thick deposits of salt that are mined in the Hutchinson area. The shale units are chiefly gray to greenish gray in color, with some red, maroon and purple beds. The consistency of the shale can be quite variable over relatively short distances, ranging from soft, with a consistency similar to that of very stiff clay, to hard with STP blow counts of 50 or more. The limestone and dolomite units are generally light colored, argillaceous and relatively thin in comparison to the shale units. The Wellington Formation also contains thick beds of salt that are extensively mined in the Hutchinson area. Published geologic reports indicated that the Wellington Formation has a maximum thickness of about 700 feet in central Kansas, where the bedrock has not been exposed to weathering.

SITE AND SUBSURFACE CONDITIONS

The Equestrian Campground is planned around a man-made lake at the Sand Hills State Park, which is located on 56th Avenue approximately ½ mile east of K-61 Highway on the northeast side of Hutchinson, Kansas. Aerial photographs from 2002 on Google Earth indicate that the Equestrian Campground site was previously undeveloped pasture and/or crop land with a few scattered trees. It is understood that about two years ago, a lake was excavated by Kansas Wildlife and Parks personnel that will form the center of the campsite parking area. The existing ground surface adjacent to the lake slopes downward from southwest to northeast at grades of less than 1 percent.

The following presents a general summary of the major strata encountered during our subsurface exploration and includes a discussion of the results of field and laboratory tests conducted. Specific subsurface conditions encountered at the boring locations are presented on the individual boring logs in Appendix A of this report. Figure 2 in Appendix A shows a Generalized Subsurface Profile, based on the information obtained from the borings. The stratification lines shown on the boring logs and profile represent the approximate boundaries between soil types; in-situ, the transition between materials may be more gradational in nature rather than clearly defined.

Boring B-1 was drilled in the vicinity of the proposed shop building and encountered about 6 inches of poorly developed topsoil at the surface. The topsoil was underlain by loose, fine grained silty sand (SM) with interbedded layers of sandy silt (ML) that continued to the bottom of the 10 foot deep borings. Standard Penetration Tests performed in the silty sands yielded "N" values in the range of 5 to 8 bpf (blows per foot of penetration). Grain size tests performed on selected samples of the alluvial sands indicated that the silty sands were fine grained and poorly graded.

Borings B-2 through B-6 were located around the perimeter of the proposed ring road and/or in the adjacent campsite parking areas. These borings encountered about 3 to 4.3 feet of existing fill at the surface. The fill was comprised of a mixture of local soils, consisting predominately of silt and sand, with some clay and trace amounts of organic material. The fill was visually classified as sandy silt (ML), lean clay (CL) and silty sand (SM). Standard Penetration Tests performed in the existing fill materials yielded "N" values in the range of 2 to 10 bpf.

A representative bulk sample of the existing fill was obtained by compositing the soils encountered within the upper 3 feet of the borings. The bulk sample was visually classified as light brown fine silty sand (SM). A grain size analysis was performed on this material and indicated that it was comprised of about 70.2 percent fine sand, 20.5 percent silt and 9.3 percent clay size material. An Atterberg Limits test indicated that is material was non-plastic. A Standard Proctor (ASTM D-698) test was performed on the bulk sample and indicated an optimum moisture content of 12.5 percent and a maximum dry density of 117.0 pcf. The results of a California Bearing Ratio test performed on this material indicated a CBR value of 0.9 for 0.1 inches of penetration.

The fill was underlain by eolian and alluvial deposited soils that continued to the bottom of the 10 foot deep borings. These soils were visually classified as silty sands (SM), fine sands (SM/SP), sandy silts (ML), and sandy lean clays (CL/SC). Standard Penetration Tests performed in these soils yielded "N" values in the range of 4 to 13 bpf. Atterberg Limits tests performed on selected samples of the natural soils indicated Liquid Limits of 23 and 28, with Plasticity Indices of 4 and 7. A number of the sandy soils were non-plastic.

GROUNDWATER OBSERVATIONS

Groundwater observations were made both during and after completion of drilling operations. As the borings were advanced, groundwater was initially encountered at depths ranging from about 3.1 to 8.0 feet below existing ground levels. Within a few hours after completion of the borings, the groundwater levels stabilized at about elevation 1574 ± 2 feet during the period that the borings were performed. The groundwater levels correspond closely with the water level of the existing lake at the time the borings were performed.

Fluctuations of groundwater levels can occur due to seasonal variations in the amount of rainfall, runoff, the level of the lake and other factors not evident at the time the borings were performed. The possibility of groundwater level fluctuations should be considered when developing the design and construction plans for the project.

CONCLUSIONS AND RECOMMENDATIONS

Based on the results of our evaluation, it is our professional opinion that the proposed project site can be developed for the proposed building and ring road pavement using conventional grading and foundation construction techniques. We have recommended that the new shop building be supported on shallow spread footings that are founded in undisturbed soils and/or controlled structural fill.

Recommendations for design and construction of foundations are presented in the following sections of this report.

The borings indicate that the upper 3 to 4 feet of the soil profile was comprised of existing fill and/or wind deposited soils that were predominately composed of fine silty sand and/or sandy silt. These soils were in a relatively loose condition, which makes them highly erodible and very poor subgrade materials for support of pavements. To mitigate the relatively poor soil conditions at this site, these materials will need to be densified and either covered with a layer of gravel or stabilized to retard future erosion. Gravel in the Hutchinson area generally has to be trucked in, making its use relatively expensive. An alternative would be to stabilize the onsite fine grained sandy soils be with Portland cement below the paved ring road and campsite parking areas. Recommendations for both alternatives are presented in the following sections of this report.

Thorough site preparation will be required to correct areas that were disturbed during the previous site grading work and fill placement activities at the site. Recommendations presented in the following sections of this report outline procedures for subgrade preparation and stabilization of the onsite soils, as well as undercutting procedures to remove unstable fill, soft soils, and other unsuitable materials. Proper fill placement techniques are also discussed that include recommended maximum lift thickness and moisture content and compaction criteria for the types of soils encountered in the borings.

The recommendations submitted herein are based, in part, upon data obtained from our subsurface exploration. Variations in subsurface and groundwater conditions may occur between the explorations points and the nature and extent of any such variations may not become evident until exposed during construction. If variations appear evident, then the recommendations presented in this report should be reevaluated. In the event that there are changes in the nature, design, locations or elevations of the proposed structures and/or paved areas, the conclusions and recommendations contained in this report should not be considered valid unless the changes are first reviewed by the geotechnical engineer and our recommendations modified in writing, if necessary.

SITE PREPARATION

Site preparation should commence with stripping of all vegetation and topsoil from planned structure and pavement areas. Based on the borings, an average stripping depth of approximately 6 inches would be anticipated for most areas. The stripping depths required will likely vary and should be adjusted to remove all vegetation and root systems. A representative of GeoSource should observe the stripping operations to evaluate that all unsuitable materials have been removed. Soils removed during site stripping operations could be used for final site grading outside the building and pavement areas. Care should be exercised to separate these materials to avoid incorporation of the organic matter in structural fill sections.

Any required tree removal should also be accomplished at this time. Care should be taken to thoroughly remove all root systems from the proposed building area. Materials disturbed during removal of stumps should be undercut and replaced with structural fill. A zone of desiccated soils may exist in the vicinity of the trees. The desiccated soils have a higher swell potential and should also be undercut and replaced with structural fill.

Relocation of any existing utility lines within the zone of influence of proposed construction areas should also be completed as part of the site preparation. The lines should be relocated to areas outside of the proposed construction. Excavations created during the removal of the existing lines should be cut wide enough to allow for use of heavy construction equipment to recompact the fill. In addition, the base of the excavations should be thoroughly evaluated by a geotechnical engineer or engineering technician prior to placement of fill. All fill should be placed in accordance with the recommendations presented in the Structural Fill section of this report.

In ring road and adjacent campsite parking areas, where existing fill was placed about 2 years ago, it is recommended that the fill be undercut to a depth of at least 12 inches below finished subgrade levels and be recompacted. Additional undercutting may be required in areas where the fill contains significant amount of organic matter or other unsuitable material and/or in areas where the subgrade is unstable after initial undercutting operations has been completed.

Following undercutting and prior to placement of any additional structural fill, it is recommended that the exposed grade be thoroughly proofrolled. Proofrolling of the subgrade provides a more stable base for placement of structural fill and aids in identifying soft or unstable areas. Soft or otherwise unsuitable areas identified during the proofrolling operation should be undercut to stable material and replaced with controlled structural fill. Proofrolling should be performed using a fully-loaded, tandem-axle dump truck or similar equipment providing an equivalent subgrade loading.

Following proofrolling, the moisture content of the exposed soils should be assessed. If portions of the subgrade are too wet or too dry (i.e., outside the moisture content range recommended for structural fill), the subgrade should either be moisture conditioned or aerated and dried until the subgrade materials are within the recommend moisture content range given in the Structural Fill section of this report.

In areas where fill will be placed on a slope that is steeper than 5 (H) to 1 (V), it is recommended that the existing slope be properly benched as fill placement progresses. These benches should be vertically stepped no more than 2 to 3 feet. This procedure would better key the fill into the original slope and will facilitate compaction of the fill.

CLIMATIC CONDITIONS

Weather conditions will influence the site preparation required. In spring and late fall, following periods of rainfall, the moisture content of the sandy soils may be significantly above the optimum moisture content. In addition, the relatively shallow groundwater table at this site may impede grading activities by causing an unstable subgrade condition. Typical remedial measures include aerating the wet subgrade, removal of the wet materials and replacing them with dry materials or treating the wet material with Portland cement.

If site grading commences during summer months, the moisture contents of the onsite soils may be abnormally low. Typically, discing and moisture conditioning of the exposed subgrade materials to the moisture content criteria outlined in the Structural Fill section. As an alternative, the dry materials could be undercut and replaced with controlled structural fill.

SOIL STABILIZATION

The fine grained sandy soils encountered at the site are relatively loose, highly erodible and frost susceptible, making these soils very poor subgrade material for support of pavement. Stabilization of the onsite fine grained sandy soils has been recommended as a means to reduce the erodible and frost susceptible nature of these soils and to also improve their strength and support capabilities below pavements.

The type of additive that will be most effective in stabilizing the onsite fine sandy soils is Portland cement. Stabilization of the upper 8 inches of the subgrade is generally required for applications where increased support capacity of the subgrade materials and extended design life of the pavement section are the primary objectives. Based on the gradation of the soils, the amount of Portland cement that will be required for proper stabilization should be in the range of about 7 to 8 percent, on a dry weight basis. Laboratory tests should be performed to determine the optimal amount of Portland cement that is required for this particular soil type. The laboratory testing should include freeze-thaw testing in addition to unconfined strength and CBR evaluations. Specifications for stabilization with Portland cement should be included in the project specifications and can be provided, if desired.

Stabilization requires that mixing and compaction operations be closely monitored by experienced personnel during construction. It is also important that the moisture content of the cement treated materials be strictly controlled, as the moisture content of the mixture at the time of compaction dictates the long term strength of the material, in that the strength of the final product is significantly affected by water/ash ratio. If too much water is added during the stabilization process, there can be a drastic reduction in the final strengths of the cement treated materials. Wet areas can occur where the mixer starts and stops, between successive passes and can result in localized areas, where moisture contents are above recommended levels.

It is recommended that the Portland cement be incorporated into the subgrade soils using a Bomag MPH-100 or other equivalent rotary mixing equipment. The mixing equipment should be equipped to allow injection of water directly into the mixing drum, as this is the most effective means of obtaining the required moisture control.

Finally, it is important that the delay time between initial mixing and final compaction be carefully limited, when using Portland cement as a stabilization agent. For this project and other similar stabilization projects, we recommend that no more than 2 hours be allowed to lapse between the incorporation of the stabilization agent and final compaction of the treated materials. Initial compaction should be accomplished with a vibratory padfoot roller operating immediately behind the mixing equipment. Final compaction should be performed using a rubber tired roller to provide uniform compaction at the surface of the stabilized section.

It should be recognized that cement treatment of subgrade soils requires suitable equipment and construction procedures to achieve optimum results. It is recommended that prospective earthwork subcontractors for this project have satisfactorily completed at least five stabilization projects of a similar nature. The contractor should identify all equipment to be used, prior to commencing the stabilization work. Adequate observation and testing by qualified personnel should be provided during the stabilization work.

EXCAVATIONS

Excavations will generally not be required for this project, except for foundations and utilities. The existing fill and naturally deposited silts and sands encountered in the borings would generally be classified as Type C soils, under Part 1926 of the OSHA regulations pertaining to open excavations. For excavations in these soils, it is recommended that temporary construction slopes be no steeper than 1.5(H) to 1(V). Flatter slopes and/or temporary shoring and/or bracing and dewatering will probably be required for excavations that extend below the water table at this site. Construction slopes should be closely observed for signs of mass movement: tension cracks near the crest, bulging at the toe, etc. If potential stability problems are observed, the contractor should take immediate corrective action. The responsibility for excavation safety and stability of temporary construction slopes should lie solely with the contractor.

STRUCTURAL FILL

All structural fill should consist of approved materials, free of organic matter and debris. Fill should be placed in lifts having a maximum loose lift thickness of 9 inches. Cohesive fill material should be compacted to a minimum of 95 percent of the material's maximum dry density as determined by ASTM D-698 (standard Proctor compaction). The moisture content of the fill at time of compaction should be within a range of minus 2 and plus 3 percent of the optimum moisture content as defined by the standard Proctor compaction procedure. Sands and sandy soils that do not have a well defined moisture-density relationship should be compacted to a minimum of 75 percent of maximum relative density as determined by ASTM D-4253 and D-4254. There is no specified moisture content range for granular fill material. The only requirement is that the moisture content of the granular material be sufficient to aid in achieving the minimum required compaction.

PERMANENT SLOPES

Permanent cut or fill slopes should be no steeper than 5(H) to 1(V) to maintain long-term stability, reduce erodibility and provide ease of maintenance. Steeper slopes in these types of soils are highly susceptible to erosion and difficult to maintain. The crest or toe of cut or fill slopes should be no closer than 10 feet from any foundation and no closer than 5 feet from the edge of any pavement.

STRUCTURE FOUNDATIONS

The types of foundations that would be suitable for support of buildings and other structures at this site are dependent on the type of structure, location, configuration and grades of the structure, as well as the magnitude of the foundation loads, sensitivity to differential settlement, thickness of new fill required for site development and other factors. Because the proposed shop building has relatively light foundation loads and the amount of site grading is expected to be relatively minor, we have recommended that the proposed building be founded on conventional spread footings that are founded in the undisturbed soils that underlie the proposed building site or in structural fill that is constructed with these soils.

SPREAD FOOTINGS

With the recommended site preparation procedures, the site should be suitable for support of the proposed shop building on conventional spread footings that are founded in undisturbed soils and/or in controlled structural fill. Support of footings on or above undocumented fill is not recommended. Footings founded in the recommended materials may be proportioned for a maximum allowable bearing pressure of 1,500 psf. The recommended bearing pressure includes a safety factor of at least 3 against a bearing failure.

Formed continuous footings should have a minimum width of 18 inches and isolated spread footings should have a minimum width of 30 inches. All exterior footings and footings founded in the unheated portions of the structures should be supported a minimum of 3 feet below final exterior grade to provide protection against frost penetration. Where possible, footings should be earth-formed, i.e., poured to lines of neat excavation.

Lateral loads acting on shallow footings resulting from short term dynamic loads, such as wind, may be resisted by the passive resistance of the native soils and by friction acting at the base of the foundation. The lateral load capacity of the structure foundation can be determined using an allowable equivalent fluid unit weight of 220 pounds per cubic foot (pcf) for calculating the passive lateral earth pressure acting on the edge of footings. This allowable equivalent fluid pressure includes a factor of safety of about 1.5. The recommended passive pressure parameter is applicable for earth-formed foundations and should be determined from final grade to the bottom of the foundation; however, the passive resistance provided in the upper 3 feet of the profile should be ignored, as this is the zone subject to moisture changes and frost penetration. For sliding friction, an allowable friction coefficient of 0.26 could be assigned to the base of the foundation. The recommended sliding friction value includes a factor of safety of about 1.5.

The base of all footing excavations should be free of all water and loose soil prior to placement of concrete. Concrete should be placed as soon as possible after excavating so that excessive drying of bearing materials does not occur. Should the soils at bearing level become excessively dry or wet, it is recommended that the affected material be removed prior to placement of concrete.

The onsite silty sands and sandy silts encountered in the borings are highly susceptible to disturbance from construction activity and water seepage. Care should be taken during excavation and construction of footings to minimize disturbance of the bearing soils.

Should a high groundwater table be encountered during construction, some water seepage into foundation excavations would be expected. The seepage rate of such water is expected to be minor and therefore it should be possible to remove it by use of temporary sump pits and pumps.

It is recommended that all footing excavations be evaluated and tested by the geotechnical engineer immediately prior to placement of foundation concrete. Unsuitable areas identified at this time should be corrected. Corrective procedures would be dependent upon conditions encountered and may include deepening of foundation elements, or undercutting of unsuitable materials and replacement with controlled structural fill.

Long-term structural settlement for shallow spread footings designed and constructed as outlined above should be minor; i.e., 1 inch or less.

SEISMIC HAZARDS DETERMINATION

Earthquake hazard evaluation is a complex task. Seismic sources must be identified and characterized, path effects must be evaluated (i.e., selection of appropriate attenuation relationships), and ground motions must be completed. Finally, an analysis of the motion with respect to the proposed construction must be made. In addition to the multi-discipline nature of this process, there is substantial parameter and modeling uncertainty associated with each of the steps. Typically, code based approaches are used for seismic hazard analyses. Our seismic hazard evaluation follows the IBC 2003 and 2006 procedures.

United States Geological Society (USGS) has developed and mapped maximum earthquake response spectra for two design levels: an earthquake having a 10% probability of exceedance in 50 years and an earthquake having a 2% probability of exceedance in 50 years. The motions developed by USGS represent soft rock conditions, which are assumed to be representative of the soil/rock that would be encountered below a depth of approximately 100 feet below existing grades at the site.

The USGS "soft rock" peak ground accelerations for the 10%/50 year and 2%/50 year events are 4.50% g and 14.20% g, respectively. Maximum spectral accelerations at the 0.2 second/1.0 second periods for the 10%/50 year and 2%/50 year events are 4.50% g / 1.90% g and 14.20% g / 4.70% g, respectively. Based on the subsurface information, the project site would be characterized as a Site Class D per the 2003 and 2006 International Building Code (IBC).

BUILDING FLOOR SLABS

The recommendations outlined in the Site Preparation and Structural Fill sections of this report are intended to produce subgrades that are suitable for support of building floor slabs. Immediately prior to construction of the building floor slab, it is recommended that the exposed subgrade be evaluated to determine whether the moisture content and dry density of the subgrade materials are within the recommended range and to identify any areas that were disturbed by construction operations. Unsuitable or disturbed areas should be reworked prior to placement of the granular leveling course and construction of the floor slab.

It is recommended that a granular leveling course, having a minimum thickness of 4 inches, be used below building floor slabs supported on soil subgrades. The granular section provides a capillary moisture break and acts as a leveling course. Clean crushed limestone gravel, with a nominal size of ½ to ¾ inch, would be recommended for the leveling course.

Subsurface moisture and moisture vapor naturally migrate upward through the soil and, where the soil is covered by a building or pavement, this moisture will collect. To reduce the impact of this subsurface moisture and the potential impact of future induced moisture (such as landscape irrigation or precipitation), the current industry standard is to place a vapor retarder below the compacted crushed limestone layer. This membrane typically consists of visquene or polyvinyl plastic sheeting, having a thickness of at least 10 mils. It should be noted that although vapor barrier systems are currently the industry standard, this system may not be completely effective in preventing floor slab moisture problems. These systems typically will not necessarily assure that floor slab moisture transmission rates will meet floor covering manufacturer standards and that indoor humidity levels be appropriate to inhibit mold growth. The design and construction of such systems are totally dependent on the proposed use and design of the proposed building and all elements of building design and function should be considered in the slab-on-grade floor design. Building design and construction may have a greater role in perceived moisture problems since sealed buildings/rooms or inadequate ventilation may produce excessive moisture in a building and affect indoor air quality.

Special precautions must be taken during the placement and curing of all concrete slabs. Excessive slump (high water-cement ratio) of the concrete and/or improper curing procedures used during either hot or cold weather conditions could lead to excessive shrinkage, cracking or curling of the slabs. High water-cement ratio and/or improper curing also greatly increase the water vapor permeability of the concrete. We recommend that all concrete placement and curing operations be performed in accordance with the American Concrete Institute (ACI) Manual.

The above procedures should reduce the potential for subgrade moisture variations and consequently reduce floor slab movement and cracking. However, these procedures will not completely eliminate the volume change characteristics of the natural clay soils and, because of the presence of unaltered clay soils that extend to much greater depths, some long-term volume change may occur along with some floor slab movement and cracking. Isolation of floor slabs from walls and columns should be considered to accommodate minor differential movement of floor slabs. If it is desired to further minimize the potential for subgrade volume change, the use of a greater thickness of low volume change material beneath the floor slab should be considered.

PAVEMENTS

The subgrade for the proposed ring road and adjacent campsite parking areas should be prepared in accordance with the recommendations given in the Site Preparation and Structural Fill sections of this report. The site soils are considered very poor subgrade materials for support of pavements. Based on the soil types encountered at this site and previous experience with materials of this type, a design CBR value of only 1 would be recommended for design of pavement sections. For this design value, a pavement section consisting of at least 6 inches of asphaltic concrete placed over either 6 inches of crushed limestone aggregate (KDOT AB-3) or over a subgrade that has been stabilized with Portland cement has been recommended for the ring road. For the unpaved campsite parking areas that will be adjacent to the ring road, we recommend that these areas be surfaced with at least 4 inches of crushed rock base over a cement treated subgrade. If the Owner elects not to cement treat the subgrade, the thickness of the crushed rock should be increased to 8 inches.

Proper drainage is a key to the long term performance of any pavement section. It is recommended that all pavements be properly sloped to provide rapid runoff of surface water. Water should not be allowed to pond on or adjacent to pavements, since this could result in saturation of the subgrade and cause premature deterioration of pavements. Pavements in Kansas are normally subjected to 30 or more freeze-thaw cycles in any given year. Because of this, periodic maintenance of all of the pavements is essential to long term performance and should be anticipated. This should include sealing of all cracks and joints and by maintaining proper surface drainage next to paved areas.

PLANS AND SPECIFICATIONS REVIEW

It is recommended that the geotechnical engineer be provided the opportunity to review the plans and specifications so that comments can be made regarding the interpretation and implementation of our geotechnical engineering recommendations in the design and specifications. It is further recommended that the geotechnical engineer be retained for testing and observation during earthwork and foundation construction phases to help determine that the design requirements are fulfilled. In the event that GeoSource is not given the opportunity to perform this recommended review, we will assume no responsibility for misinterpretation of our geotechnical engineering recommendations.

CONSTRUCTION OBSERVATION AND TESTING

To effectively achieve the intent of the geotechnical recommendations presented in this report and to maintain continuity from design through construction, GeoSource should be retained to provide observation and testing services during earthwork and foundation construction phases of the project.

This will provide the geotechnical engineer with the opportunity to observe the subsurface conditions encountered during construction, evaluate the applicability of the geotechnical recommendations presented in our report as they relate to the soil and bedrock conditions encountered, and to provide follow up recommendations if conditions differ from those described in our report.

LIMITATIONS

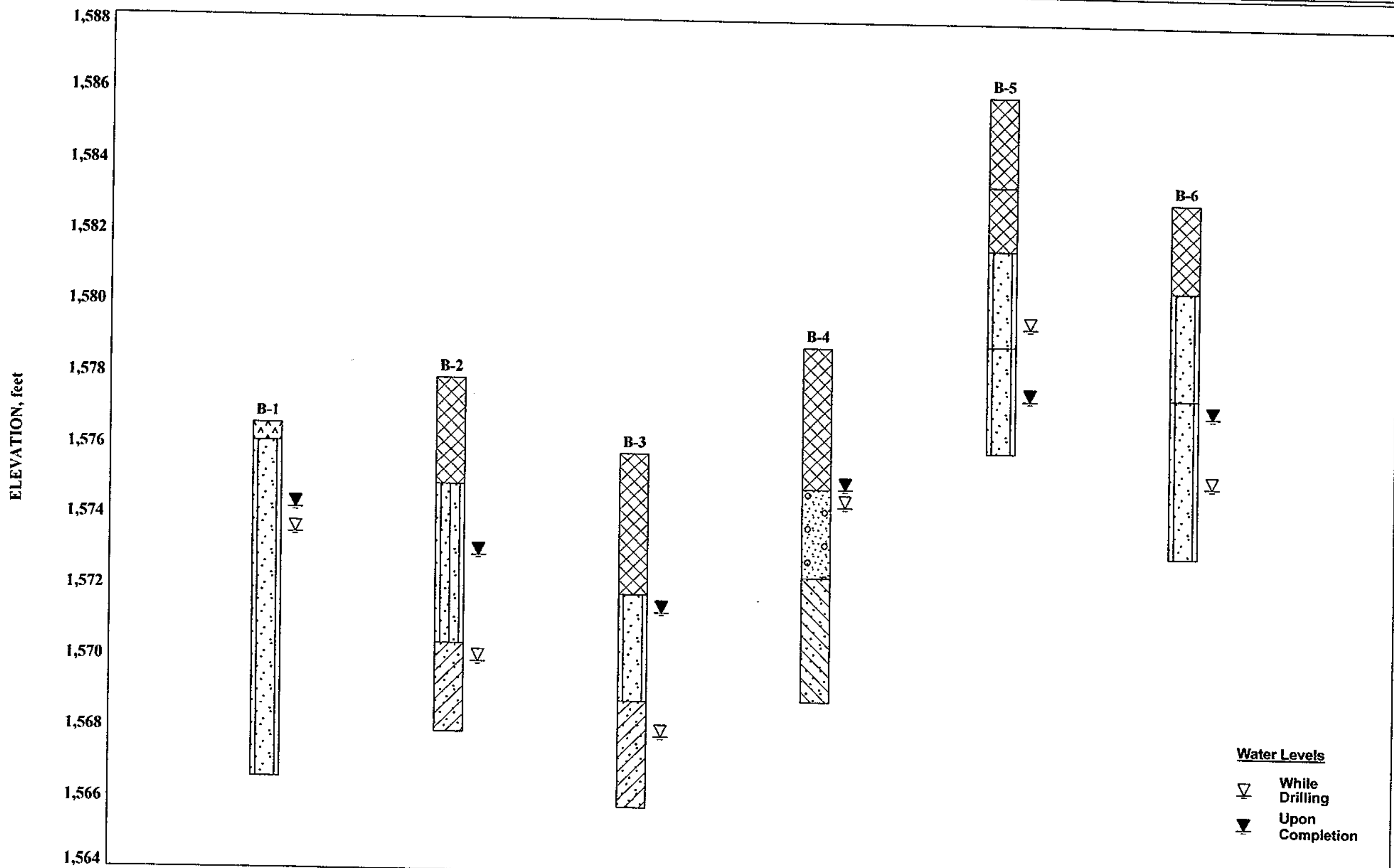
The analysis and recommendations submitted in this report are based in part upon the subsurface information obtained from the exploration points performed at the indicated locations and our present knowledge of the proposed construction as outlined in the Project Description. Subsurface conditions may vary between the exploration points and across the site and our report does not reflect any variations which may occur. The nature and extent of such variations may not become evident until construction. If subsurface conditions are encountered during construction that differ from those described in this report, GeoSource should be notified immediately so that a review may be made and any supplemental recommendations provided. If the scope of the proposed construction, including the proposed loads, floor slab elevations or locations, changes from that described in this report, our recommendations should also be reviewed and the recommendations modified accordingly.

This report has been prepared in accordance with the generally accepted geotechnical engineering practice as it exists in the area at the time of our study. No warranty is expressed or implied. The recommendations provided in this report are based on the assumption that an adequate program of observation and testing will be conducted during the construction phase in order to evaluate compliance with our recommendations. Our scope of services did not include any environmental assessment or exploration for the presence of hazardous or toxic materials in the soil, surface water, groundwater or air, on, below or around this site.

This report has been prepared for the exclusive use of our client for specific application to the project discussed. Any party other than the client who wishes to use this report shall notify GeoSource in writing of such intended use. Additional work may be required before an updated report can be issued. Non-compliance with any of these requirements will release GeoSource from any liability resulting from the use of this report by any unauthorized party and client agrees to defend, indemnify and hold harmless GeoSource from any claim or liability associated with such unauthorized or non-compliance.

APPENDIX A

FIGURES 1 & 2: BORING LOCATION SKETCHES
FIGURE 3: GENERALIZED SUBSURFACE PROFILE
BORING LOGS
GENERAL NOTES AND TERMS
BORING LOG SYMBOLS



GENERALIZED SUBSURFACE PROFILE

FIGURE 2

Proposed Equestrian Campground

Sand Hills State Park, 4207 E. 56th Street

Hutchinson, Kansas

Approved By: JJZ

Project No.: D10G0332

LEGEND

Topsoil
Fill
Fat Clay
Sandy Lean Clay
Lean to Fat Clay
Clayey Sand
Silty Sand
Sandy Silt
Sand (SP)

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BOREHOLE INFORMATION	Page 1 of 1
STATION	OFFSET
NORTHING	EASTING
DRILLING COMPANY Kaw Valley Contract Drilling	
METHOD 4-inch Flight Augers	HAMMER Auto

LOG OF BORING NO. B-1

PROJECT NAME	Proposed Equestrian Campground
SITE LOCATION	Sand Hills State Park, 4207 E. 56th Street Hutchinson, Kansas
OWNER / ENGINEER	KS Wildlife & Parks / Schwab-Eaton PA

SAMPLE NO.	SAMPLE TYPE	RECOVERY	STANDARD PENETRATION BLOWS/FT.	UNCONFINED STRENGTH PSF	DRY DENSITY PCF	MOISTURE CONTENT, %	UNIFIED SOIL SYMBOL	GRAPHIC LOG	DEPTH, Feet.	MATERIAL DESCRIPTION (Surface Elevation: 1576.6)
	PA								0.5	**Topsoil**, dark gray sandy silt (6") — 1576.1
1	SS	18	5			19.6	SM			**SILTY SAND**, loose, fine grained, poorly graded, light brown to brown, with interbedded seams of sandy silt
	PA									
2	SS	18	6			20.8	SM		5	
	PA									
3	SS	18	8			21.2	SM		10.0	1566.6
									10	**BOTTOM OF BORING**

* Calibrated Penetrometer

The stratification lines represent the approximate boundary lines between soil and rock types. In-situ the transition may be more gradational in nature.

WATER LEVEL OBSERVATIONS	
▽ 3.1	feet W.D.
▼ 2.4	feet W.C.I.
Backfilled @ Completion	

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BORING STARTED	2-12-10		
BORING COMPLETED	2-12-10		
RIG	ATV-45	DRILLER	LS
APPROVED	JJZ	JOB No.	D10G0332

BOREHOLE INFORMATION	Page 1 of 1
STATION	OFFSET
NORTHING	EASTING
DRILLING COMPANY	Kaw Valley Contract Drilling
METHOD 4-inch Flight Augers	HAMMER Auto

LOG OF BORING NO. B-2

PROJECT NAME **Proposed Equestrian Campground**

SITE LOCATION **Sand Hills State Park, 4207 E. 56th Street Hutchinson, Kansas**

OWNER / ENGINEER **KS Wildlife & Parks / Schwab-Eaton PA**

SAMPLE NO.	SAMPLE TYPE	RECOVERY	STANDARD PENETRATION BLOWS/FT.	UNCONFINED STRENGTH PSF	DRY DENSITY PCF	MOISTURE CONTENT, %	UNIFIED SOIL SYMBOL	GRAPHIC LOG	DEPTH, Feet.	MATERIAL DESCRIPTION (Surface Elevation: 1577.9)
	PA									**FILL**, sandy silt, very loose, light brown
1	SS	18	4			16.8	ML			
	PA								3.0	1574.9
2	SS	18	7			19.9	ML SM			**SANDY SILT**, medium stiff, fine grained, light gray brown, with interbedded layers of silty sand
	PA								5	▼
									7.5	1570.4
										SANDY LEAN CLAY, medium stiff, light reddish brown mottled light gray ▽
3	SS	18	5	*1500		21.7	CL SC			
									10.0	1567.9
										BOTTOM OF BORING

* Calibrated Penetrometer

The stratification lines represent the approximate boundary lines between soil and rock types. In-situ the transition may be more gradational in nature.

WATER LEVEL OBSERVATIONS
▽ 8.0 feet W.D.
▼ 5.0 feet @ 1 hr. A.B.
Backfilled @ Completion

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BORING STARTED	2-12-10		
BORING COMPLETED	2-12-10		
RIG	ATV-45	DRILLER	LS
APPROVED	JJZ	JOB No.	D10G0332

BOREHOLE INFORMATION	Page 1 of 1	LOG OF BORING NO. B-3
STATION	OFFSET	PROJECT NAME: Proposed Equestrian Campground
NORTHING	EASTING	SITE LOCATION: Sand Hills State Park, 4207 E. 56th Street Hutchinson, Kansas
DRILLING COMPANY: Kaw Valley Contract Drilling		
METHOD: 4-inch Flight Augers	HAMMER: Auto	OWNER / ENGINEER: KS Wildlife & Parks / Schwab-Eaton PA

SAMPLE NO.	SAMPLE TYPE	RECOVERY	STANDARD PENETRATION BLOWS/FT.	UNCONFINED STRENGTH PSF	DRY DENSITY PCF	MOISTURE CONTENT, %	UNIFIED SOIL SYMBOL	GRAPHIC LOG	DEPTH, Feet.	MATERIAL DESCRIPTION (Surface Elevation: 1576.2)
	PA									**FILL**, silty sand, loose, gray brown, some clay
1	SS	18	10			13.6	SM			
	PA									
									4.0	1572.2
2	SS	18	8			16.4	SM			**SILTY SAND**, loose, fine grained, poorly graded, light brown to gray brown
	PA								5	▼
									7.0	1569.2
										SANDY LEAN CLAY, medium stiff, light reddish brown mottled light gray, with interbedded seams of silty sand ▽
3	SS	18	5	*2000		19.2	CL SC			
									10 / 10.0	1566.2
										BOTTOM OF BORING

* Calibrated Penetrometer

The stratification lines represent the approximate boundary lines between soil and rock types. In-situ the transition may be more gradational in nature.

WATER LEVEL OBSERVATIONS	BORING STARTED	2-12-10
▽ 8.0 feet W.D.	BORING COMPLETED	2-12-10
▼ 6.1 feet @ 3 hrs. A.B.	RIG: ATV-45	DRILLER: LS
Backfilled @ Completion	APPROVED: JJZ	JOB No. D10G0332

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BOREHOLE INFORMATION		Page 1 of 1
STATION	OFFSET	
NORTHING	EASTING	
DRILLING COMPANY	Kaw Valley Contract Drilling	
METHOD	4-inch Flight Augers	HAMMER Auto

LOG OF BORING NO. B-4

PROJECT NAME	Proposed Equestrian Campground
SITE LOCATION	Sand Hills State Park, 4207 E. 56th Street Hutchinson, Kansas
OWNER / ENGINEER	KS Wildlife & Parks / Schwab-Eaton PA

SAMPLE NO.	SAMPLE TYPE	RECOVERY	STANDARD PENETRATION BLOWS/FT.	UNCONFINED STRENGTH PSF	DRY DENSITY PCF	MOISTURE CONTENT, %	UNIFIED SOIL SYMBOL	GRAPHIC LOG	DEPTH, Feet.	MATERIAL DESCRIPTION Surface Elevation: 1578.9
	PA									**FILL**, sandy silt, very loose, light brown, with sandy clay seams
1	SS	18	2	*500		16.9	ML SC			
	PA									
2	SS	18	8			20.5	SP SM		4.0	1574.9 **SAND**, loose, fine grained, poorly graded, light brown, trace silt
	PA								5 6.5	1572.4 **CLAYEY SAND**, loose, light brown, trace silt
3	SS	18	6	*1500		19.1	SC		10 10.0	1568.9 **BOTTOM OF BORING**

* Calibrated Penetrometer

The stratification lines represent the approximate boundary lines between soil and rock types. In-situ the transition may be more gradational in nature.

WATER LEVEL OBSERVATIONS	
∇ 4.5	feet W.D.
▼ 6.0	feet @ 4 hrs. A.B.
Backfilled @ Completion	

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BORING STARTED	2-12-10		
BORING COMPLETED	2-12-10		
RIG	ATV-45	DRILLER	LS
APPROVED	JJZ	JOB No.	D10G0332

BOREHOLE INFORMATION

LOG OF BORING NO. B-5

STATION	OFFSET
NORTHING	EASTING
DRILLING COMPANY	Kaw Valley Contract Drilling
METHOD	4-inch Flight Augers
HAMMER	Auto

PROJECT NAME	Proposed Equestrian Campground
SITE LOCATION	Sand Hills State Park, 4207 E. 56th Street Hutchinson, Kansas
OWNER / ENGINEER	KS Wildlife & Parks / Schwab-Eaton PA

SAMPLE NO.	SAMPLE TYPE	RECOVERY	STANDARD PENETRATION BLOWS/FT.	UNCONFINED STRENGTH PSF	DRY DENSITY PCF	MOISTURE CONTENT, %	UNIFIED SOIL SYMBOL	GRAPHIC LOG	DEPTH, Feet.	MATERIAL DESCRIPTION (Surface Elevation: 1586.0)
	PA									**FILL**, sandy silt, loose, light brown, trace organic material
1	SS	18	7			21.2	ML SM		2.5	1583.5
	PA									**FILL**, lean clay, stiff, gray brown, trace organics
2	SS	18	13			12.7	CL SM		4.3	1581.7
	PA								5	**SILTY SAND**, medium dense, fine grained, poorly graded, light gray brown ∇
									7.0	1579.0
										SILTY SAND, very loose, fine grained, poorly graded, light brown ▼
3	SS	18	4			22.1	SM		10.0	1576.0
									10	**BOTTOM OF BORING**

* Calibrated Penetrometer

The stratification lines represent the approximate boundary lines between soil and rock types. In-situ the transition may be more gradational in nature.

WATER LEVEL OBSERVATIONS
∇ 6.5 feet W.D.
▼ 8.5 feet @ 2 hrs. A.B.
Backfilled @ Completion

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BORING STARTED	2-12-10		
BORING COMPLETED	2-12-10		
RIG	ATV-45	DRILLER	LS
APPROVED	JJZ	JOB No.	D10G0332

BOREHOLE INFORMATION	Page 1 of 1
STATION	OFFSET
NORTHING	EASTING
DRILLING COMPANY Kaw Valley Contract Drilling	
METHOD 4-inch Flight Augers	HAMMER Auto

LOG OF BORING NO. B-6

PROJECT NAME Proposed Equestrian Campground

SITE LOCATION Sand Hills State Park, 4207 E. 56th Street Hutchinson, Kansas

OWNER / ENGINEER KS Wildlife & Parks / Schwab-Eaton PA

SAMPLE NO.	SAMPLE TYPE	RECOVERY	STANDARD PENETRATION BLOWS/FT.	UNCONFINED STRENGTH PSF	DRY DENSITY PCF	MOISTURE CONTENT, %	UNIFIED SOIL SYMBOL	DEPTH, Feet	MATERIAL DESCRIPTION (Surface Elevation: 1583.1)
	PA								FILL, silty sand, loose, gray brown, trace clay
1	SS	18	6	*1500		17.8	ML	2.5	1580.6
	PA								SILTY SAND, loose, fine grained, poorly graded, light bronw to light reddish brown
2	SS	18	6			21.1	SM ML	5.5	1577.6
	PA								SILTY SAND, loose, fine grained, poorly graded, light brown
3	SS	18	8			17.8	SM	10.0	1573.1
									BOTTOM OF BORING

* Calibrated Penetrometer

The stratification lines represent the approximate boundary lines between soil and rock types. In-situ the transition may be more gradational in nature.

WATER LEVEL OBSERVATIONS
∇ 8.0 feet W.D.
▼ 6.6 feet @ 1.5 hrs. A.B.
Backfilled @ Completion

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BORING STARTED	2-12-10		
BORING COMPLETED	2-12-10		
RIG	ATV-45	DRILLER	LS
APPROVED	JJZ	JOB No.	D10G0332

UNIFIED SOIL CLASSIFICATION (ASTM D-2487-98)

MATERIAL TYPES	CRITERIA FOR ASSIGNING SOIL GROUP NAMES			GROUP SYMBOL	SOIL GROUP NAMES & LEGEND
COARSE-GRAINED SOILS >50% RETAINED ON NO. 200 SIEVE	GRAVELS >50% OF COARSE FRACTION RETAINED ON NO 4. SIEVE	CLEAN GRAVELS <5% FINES	Cu>4 AND 1<Cc<3	GW	WELL-GRADED GRAVEL
			Cu>4 AND 1>Cc>3	GP	POORLY-GRADED GRAVEL
		GRAVELS WITH FINES >12% FINES	FINES CLASSIFY AS ML OR CL	GM	SILTY GRAVEL
			FINES CLASSIFY AS CL OR CH	GC	CLAYEY GRAVEL
	SANDS >50% OF COARSE FRACTION PASSES ON NO 4. SIEVE	CLEAN SANDS <5% FINES	Cu>6 AND 1<Cc<3	SW	WELL-GRADED SAND
			Cu>6 AND 1>Cc>3	SP	POORLY-GRADED SAND
		SANDS AND FINES >12% FINES	FINES CLASSIFY AS ML OR CL	SM	SILTY SAND
			FINES CLASSIFY AS CL OR CH	SC	CLAYEY SAND
FINE-GRAINED SOILS >50% PASSES NO. 200 SIEVE	SILTS AND CLAYS LIQUID LIMIT<50	INORGANIC	PI>7 AND PLOTS>"A" LINE	CL	LEAN CLAY
			PI>4 AND PLOTS<"A" LINE	ML	SILT
		ORGANIC	LL (oven dried)/LL (not dried)<0.75	OL	ORGANIC CLAY OR SILT
	SILTS AND CLAYS LIQUID LIMIT>50	INORGANIC	PI PLOTS >"A" LINE	CH	FAT CLAY
			PI PLOTS <"A" LINE	MH	ELASTIC SILT
		ORGANIC	LL (oven dried)/LL (not dried)<0.75	OH	ORGANIC CLAY OR SILT
HIGHLY ORGANIC SOILS		PRIMARILY ORGANIC MATTER, DARK IN COLOR, AND ORGANIC ODOR		PT	PEAT

BEDROCK AND OTHER MATERIAL SYMBOLS

Weathered Shale	Topsoil
Shale	Asphaltic Concrete
Seamy Limestone	Concrete
Joint or Void	Fill
Limestone	Rubble or Debris Fill
Weathered Sandstone	Boulders and Cobble
Sandstone	Granular Baserock
Coal	Lean to Fat Clay

BEDROCK PROPERTIES & DESCRIPTIONS

ROCK QUALITY DESIGNATION

DESCRIPTION	RQD (%)
Very Poor	0 - 25
Poor	25 - 50
Fair	50 - 75
Good	75 - 90
Excellent	90 -100

BEDDING CHARACTERISTICS

TERM	THICKNESS (inches)
Massive	> 60
Very Thick Bedded	36 - 60
Thick Bedded	12 - 36
Medium Bedded	4 - 12
Thin Bedded	1 - 4
Very Thin Bedded	0.4 - 1
Laminated	< 0.4

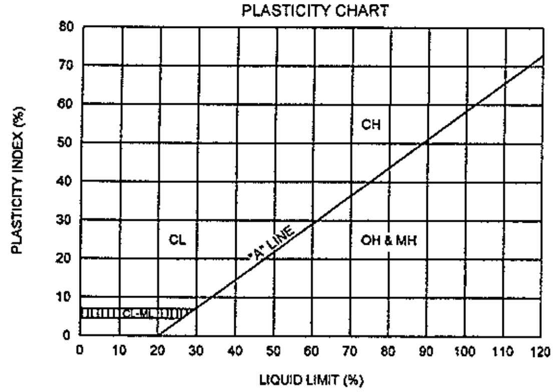
DEGREE OF WEATHERING

Slightly Weathered - Slight decomposition of Parent material in joints and seams.
Weathered - Well-developed and decomposed joints and seams.
Highly Weathered - Rock highly decomposed, may be extreemly broken.

BEDROCK DISCONTINUITIES

Bedding Planes Planes dividing the individual layers, beds or strata of rocks.
Joints Fractures in rock, generally more or less vertical to the bedding.
Seams Applies to bedding planes with an unspecified degree of weathering.

PLASTICITY CHART



PENETRATION RESISTANCE
(RECORDED AS BLOWS / 0.5 FT)

SAND & GRAVEL		SILT & CLAY		
RELATIVE DENSITY	BLOWS/FOOT*	CONSISTENCY	BLOWS/FOOT*	COMPRESSIVE STRENGTH (TSF)
VERY LOOSE	0 - 4	VERY SOFT	0 - 2	0 - 0.25
LOOSE	4 - 10	SOFT	2 - 4	0.25 - 0.50
MEDIUM DENSE	10 - 30	MEDIUM STIFF	4 - 8	0.50 - 1.0
DENSE	30 - 50	STIFF	8 - 15	1.0 - 2.0
VERY DENSE	OVER 50	VERY STIFF	15 - 30	2.0 - 4.0
		HARD	OVER 30	OVER 4.0

* NUMBER OF BLOWS OF 140 LB HAMMER FALLING 30 INCHES TO DRIVE A 2 INCH O.D. (1-3/8 INCH I.D.) SPLIT-BARREL SAMPLER THE LAST 12 INCHES OF AN 18-INCH DRIVE (ASTM-1586 STANDARD PENETRATION TEST).

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General Notes and Terms

BORING LOG SYMBOLS

SURFACE MATERIALS

- TOPSOIL
- FILL MATERIAL
- ASPHALTIC CONCRETE
- CONCRETE
- GRANULAR BASE

COHESIVE SOILS

- SILT
- CLAYEY SILT
- LEAN CLAY
- LEAN TO FAT CLAY
- FAT CLAY

LARGE GRANULAR SOILS

- CLAYEY GRAVEL
- SILTY GRAVEL
- POORLY GRADED GRAVEL
- WELL GRADED GRAVEL
- COBBLES & BOULDERS

GRANULAR SOILS

- SANDY SILT
- SILTY SAND
- FINE SAND
- POORLY GRADED SAND
- WELL GRADED SAND
- GRAVELLY SAND

BEDROCK UNITS

- SHALE
- FISSILE SHALE
- SANDSTONE
- LIMESTONE
- COAL

WEATHERED BEDROCK

- JOINT OR VOID
- WEATHERED SHALE
- WEATHERED SANDSTONE
- WEATHERED LIMESTONE

APPENDIX B

STANDAR PROCTOR RESULTS
CALIFORNIA BEARING RATIO RESULTS
GRAIN SIZE DISTRIBUTION CURVES

Summary of Laboratory Results

Boring No.	Depth	Sample Type	Recovery (inches)	Unconfined Strength (psf)	Strain at Failure (%)	Dry Density (pcf)	Water Content (%)	Unified Class	Liquid Limit	Plastic Limit	Plasticity Index
A	0.0-3.0	BULK						SM	NP	NP	NP
B-1	1.0-2.5	SS	18				19.6	SM	NP	NP	NP
B-1	3.5-5.0	SS	18				20.8	SM			
B-1	8.5-10.0	SS	18				21.2	SM			
B-2	1.0-2.5	SS	18				16.8	ML			
B-2	3.5-5.0	SS	18				19.9	ML-SM			
B-2	8.5-10.0	SS	18				21.7	CL-SC			
B-3	1.0-2.5	SS	18				13.6	SM	28	23	5
B-3	3.5-5.0	SS	18				16.4	SM			
B-3	8.5-10.0	SS	18				19.2	CL-SC			
B-4	1.0-2.5	SS	18				16.9	ML-SC			
B-4	3.5-5.0	SS	18				20.5	SP-SM	NP	NP	NP
B-4	8.5-10.0	SS	18				19.1	SC	23	16	7
B-5	1.0-2.5	SS	18				21.2	ML-SM			
B-5	3.5-5.0	SS	18				12.7	CL-SM	23	19	4
B-5	8.5-10.0	SS	18				22.1	SM			
B-6	1.0-2.5	SS	18				17.8	ML	NP	NP	NP
B-6	3.5-5.0	SS	18				21.1	SM-ML			
B-6	8.5-10.0	SS	18				17.8	SM	NP	NP	NP

Proposed Equestrian Campground
Sand Hills State Park, 4207 E. 56th Street
Hutchinson, Kansas

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MOISTURE-DENSITY RELATIONSHIP

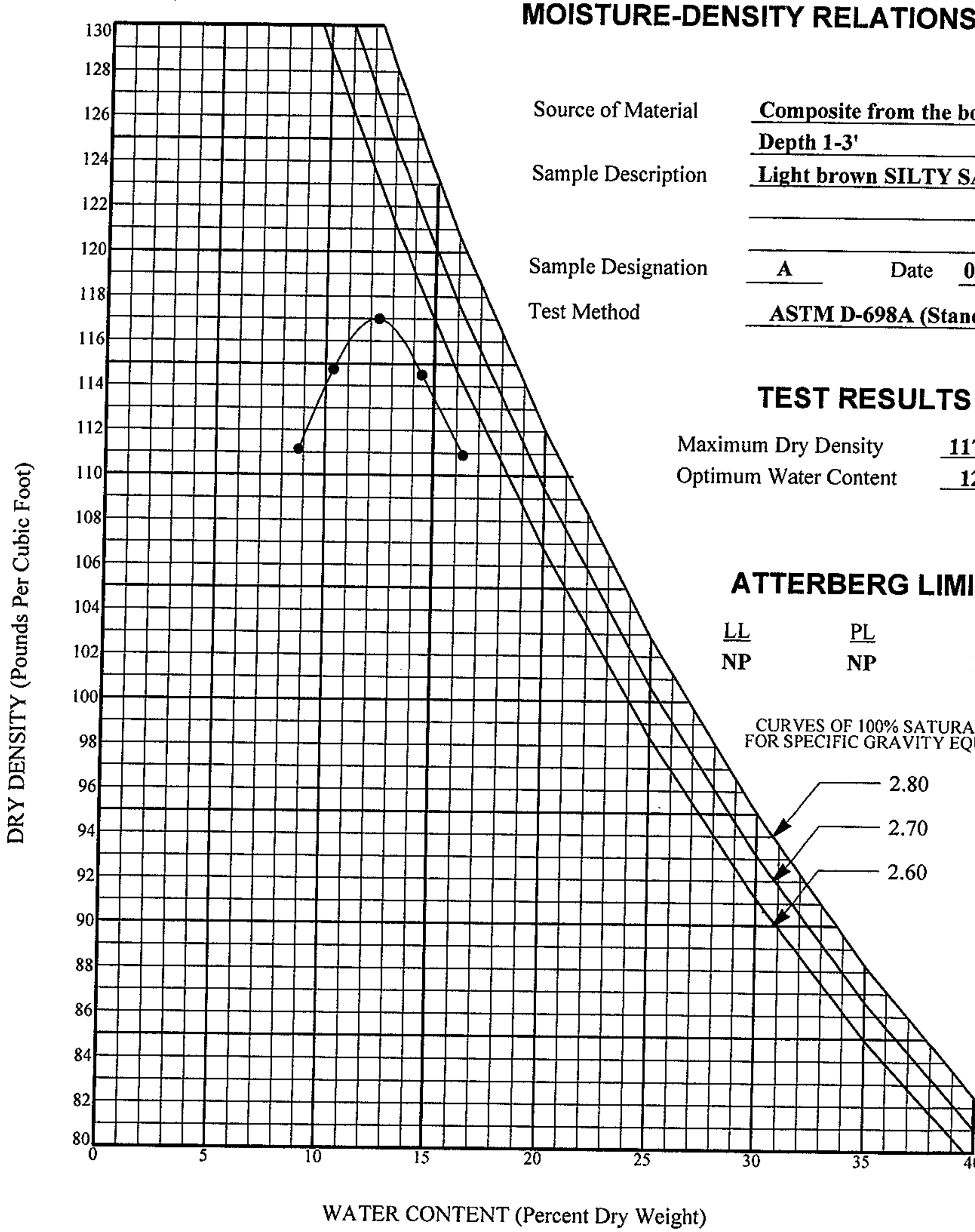
Source of Material	Composite from the borings, Depth 1-3'
Sample Description	Light brown SILTY SAND
Sample Designation	A
Date	02/24/10
Test Method	ASTM D-698A (Standard)

TEST RESULTS

Maximum Dry Density 117.0 pcf
Optimum Water Content 12.5 %

ATTERBERG LIMITS

LL	PL	PI
NP	NP	NP



Proposed Equestrian Campground
Sand Hills State Park, 4207 E. 56th Street
Hutchinson, Kansas

Approved By: JJZ | **Project No.: D10G0332**

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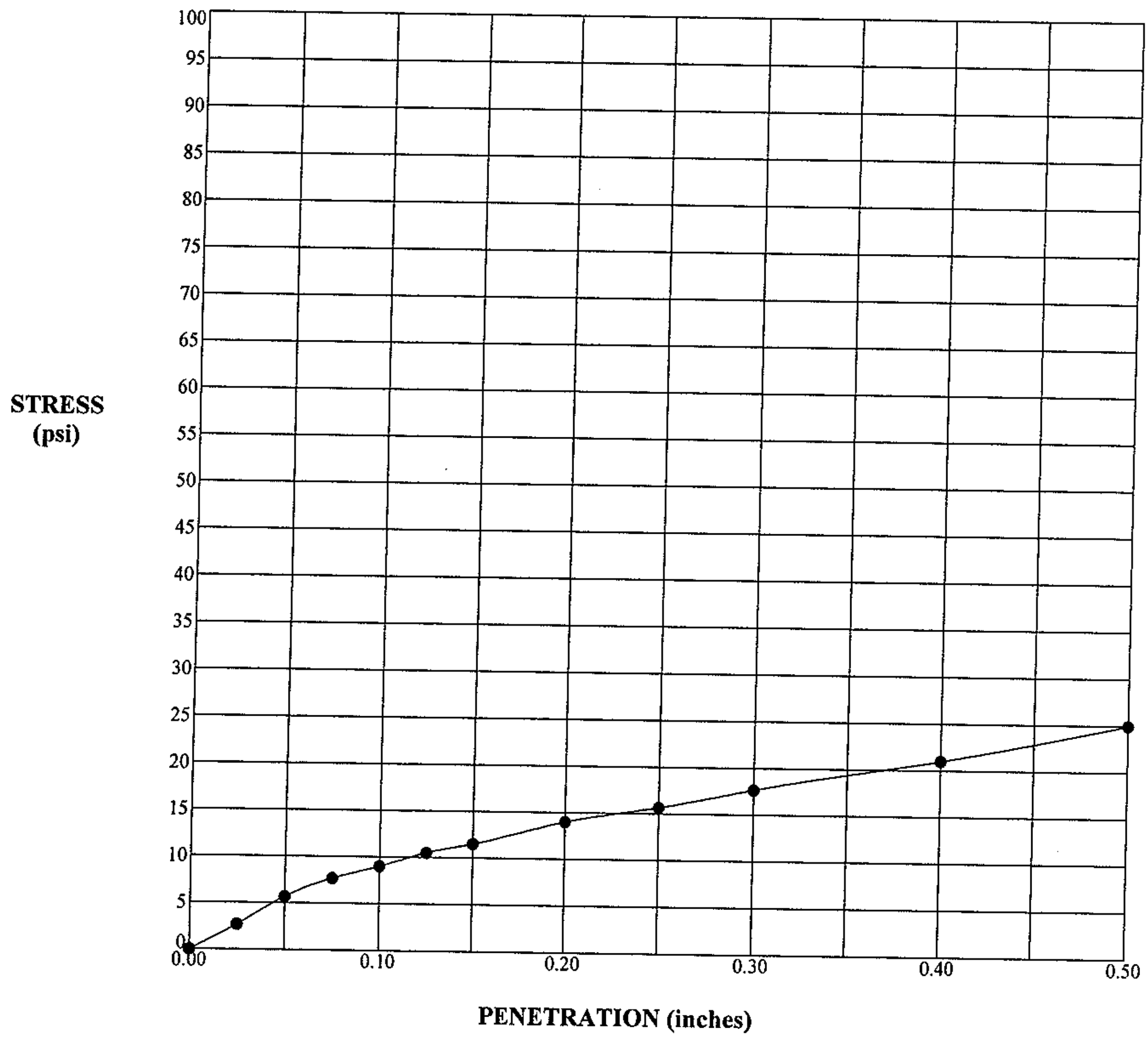
LABORATORY CBR TEST REPORT



Method of Compaction	ASTM D-698	Test Date	2/24/2010	At Molding	After Test
Mold Size 6.0 in.	Soaked 96 hours	Water Content (%)		2.4	19.5
Surcharge Weight (lbs)	10	Dry Density (pcf)		99.5	101.8
Percent Swell	0.00	Compaction (%)			
Bearing Ratio @ 0.1"	0.9	Water Content (%)		(Top 1-inch)	24.7
Liquid Limit NP	Plastic Limit NP	Plasticity Index	NP	Unified Classification	CH
Description	Light brown SILTY SAND			Bulk Sample: A	Depth 1-5 feet

Proposed Equestrian Campground

Sand Hills State Park, 4207 E. 56th Street

Hutchinson, Kansas

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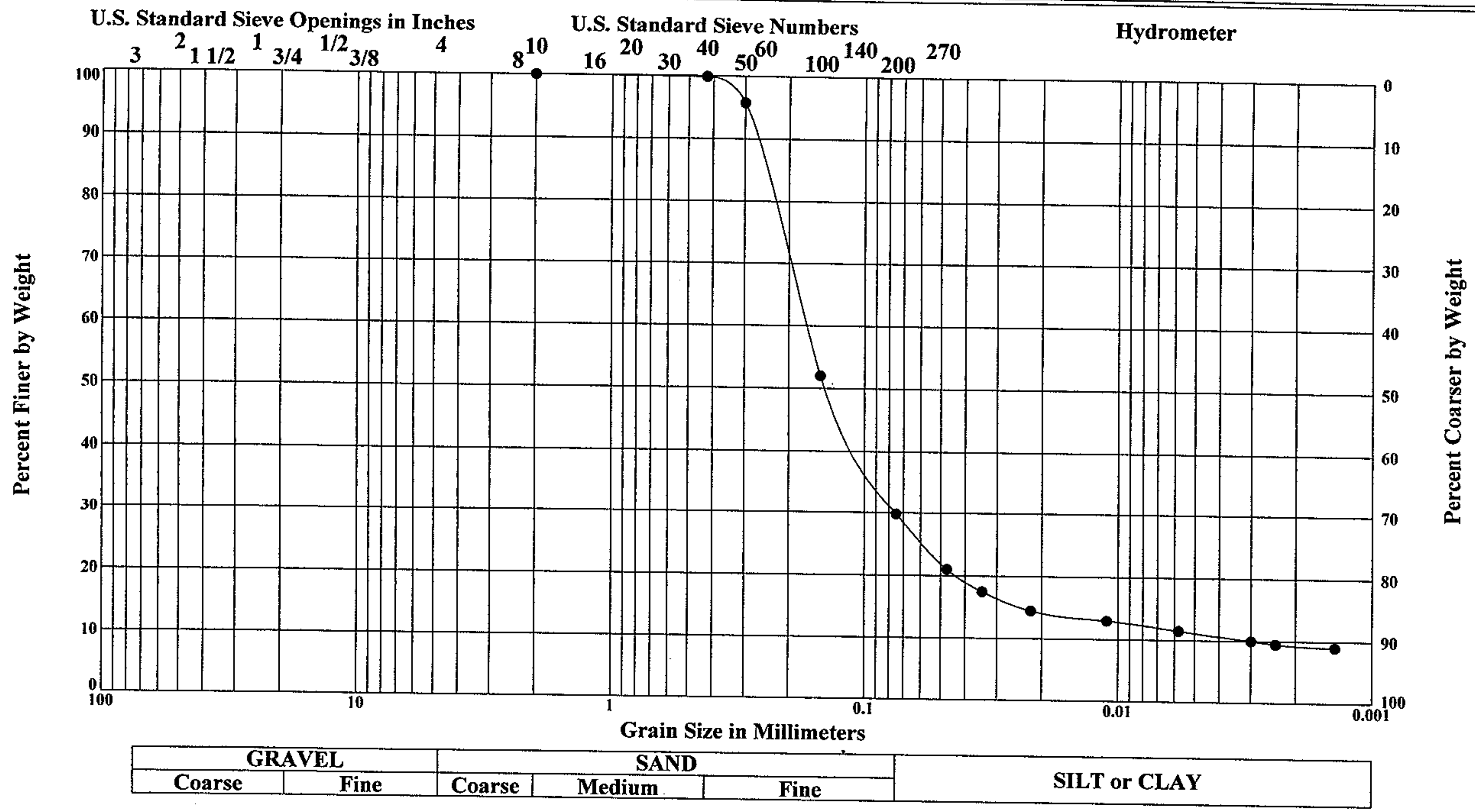

Grain Size Distribution Curve

Boring No.	Sample Type	Depth	Description	Unified Symbol	Specific Gravity	LL	PL	PI
● A	BULK-	0.0-3.0	Light brown SILTY SAND	SM	2.65	NP	NP	NP

Proposed Equestrian Campground
Sand Hills State Park, 4207 E. 56th Street
Hutchinson, Kansas

Approved By: JJZ

Project No.: D10G0332

Source: Composite from the borings, Depth 1-3'

70.2% Sand 20.5% Silt 9.3% Clay

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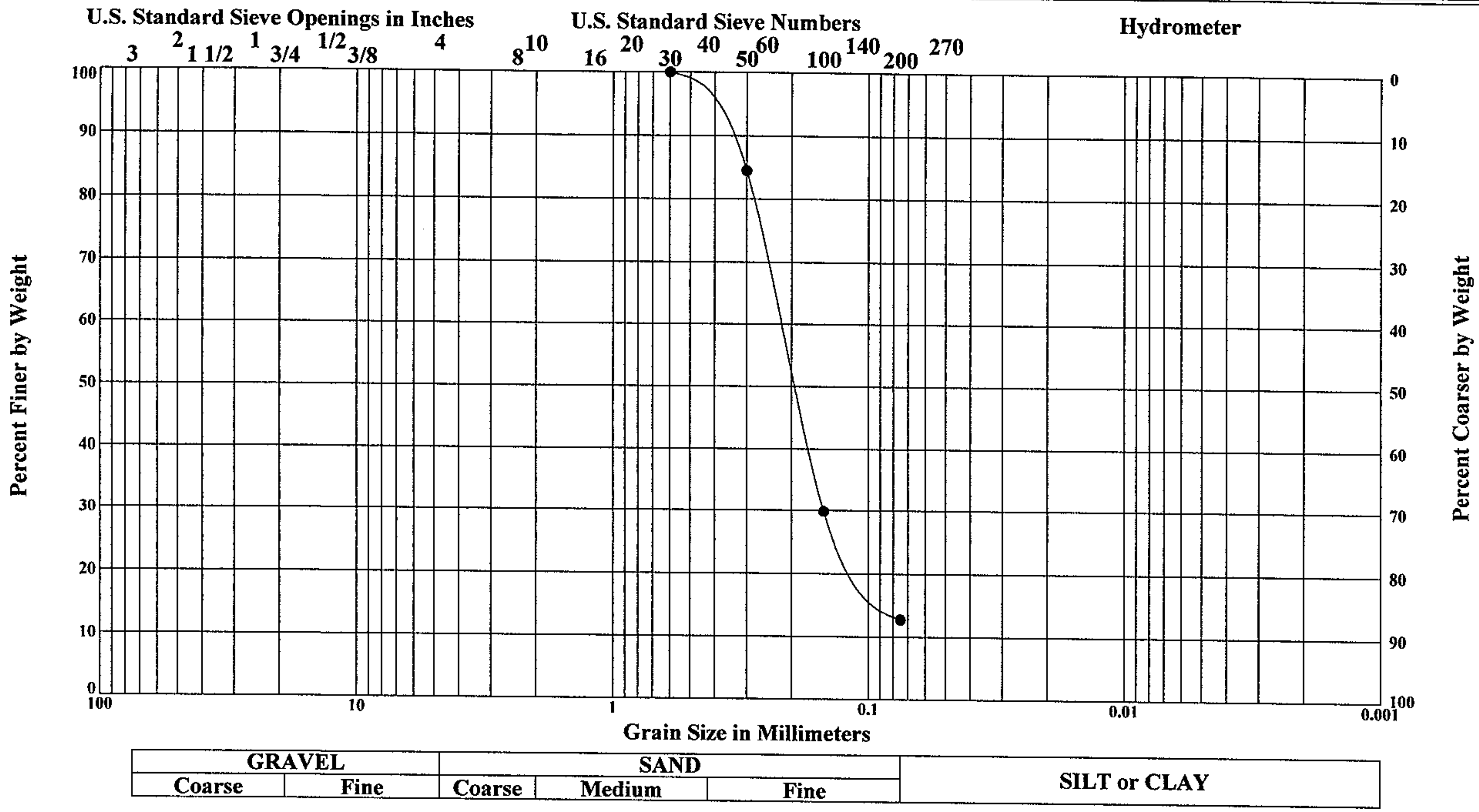

Grain Size Distribution Curve

Boring No.	Sample Type	Depth	Description	Unified Symbol	Specific Gravity	LL	PL	PI
● B-1	SS-1	1.0-2.5	Light brown fine grained SILTY SAND	SM		NP	NP	NP

Proposed Equestrian Campground
Sand Hills State Park, 4207 E. 56th Street
Hutchinson, Kansas

Approved By: JJZ

Project No.: D10G0332

Source:

87.3% Sand % Silt % Clay

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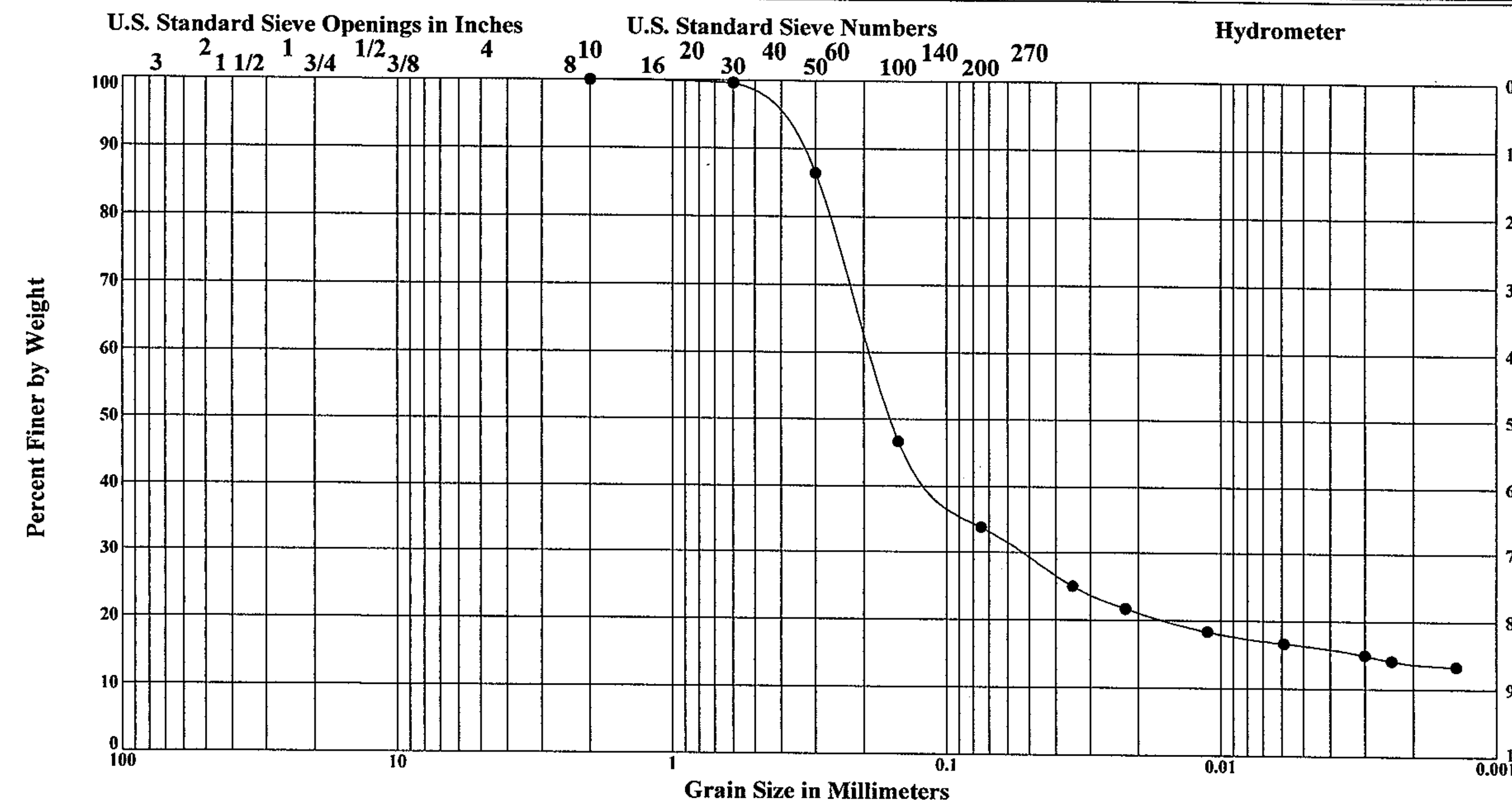

GRAVEL		SAND			SILT or CLAY
Coarse	Fine	Coarse	Medium	Fine	

Grain Size Distribution Curve

Boring	Sample Type	Depth	Description	Unified Symbol	Specific Gravity	LL	PL	PI
● B-3	SS-1	1.0-2.5	Gray brown SILTY SAND, some clay	SM	2.65	28	23	5

Proposed Equestrian Campground
Sand Hills State Park, 4207 E. 56th Street
Hutchinson, Kansas

0.0% Gravel 66.1% Sand 33.9% Fines

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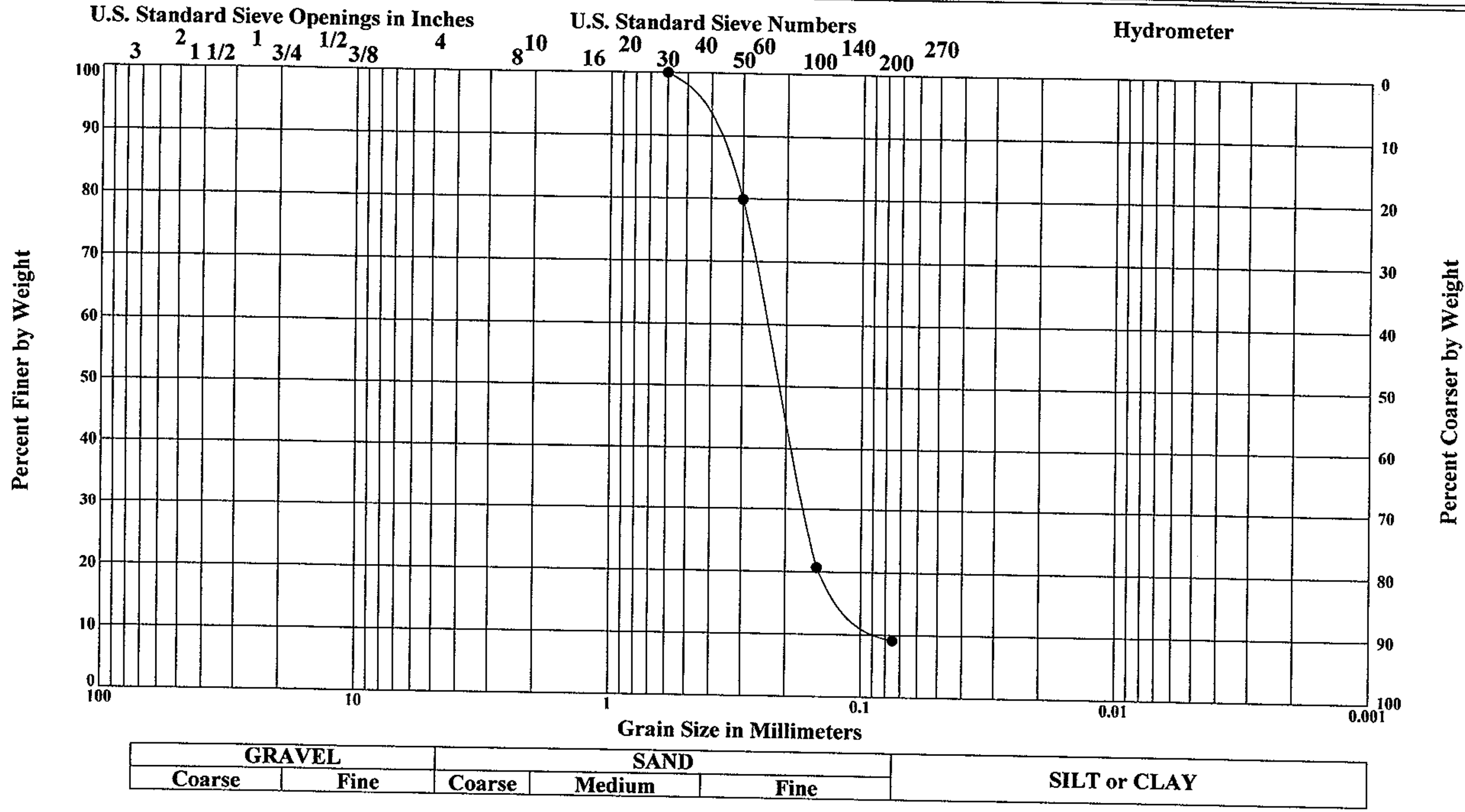
Approved By: JJZ

Project No.: D10G0332



Grain Size Distribution Curve

Boring	Sample Type	Depth	Description	Unified Symbol	Specific Gravity	LL	PL	PI
● B-4	SS-2	3.5-5.0	Light brown fine grained SAND, trace silt	SP-SM		NP	NP	NP

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Hutchinson, Kansas

Approved By: JJZ

Project No.: D10G0332

0.0% Gravel 90.9% Sand 9.1% Fines

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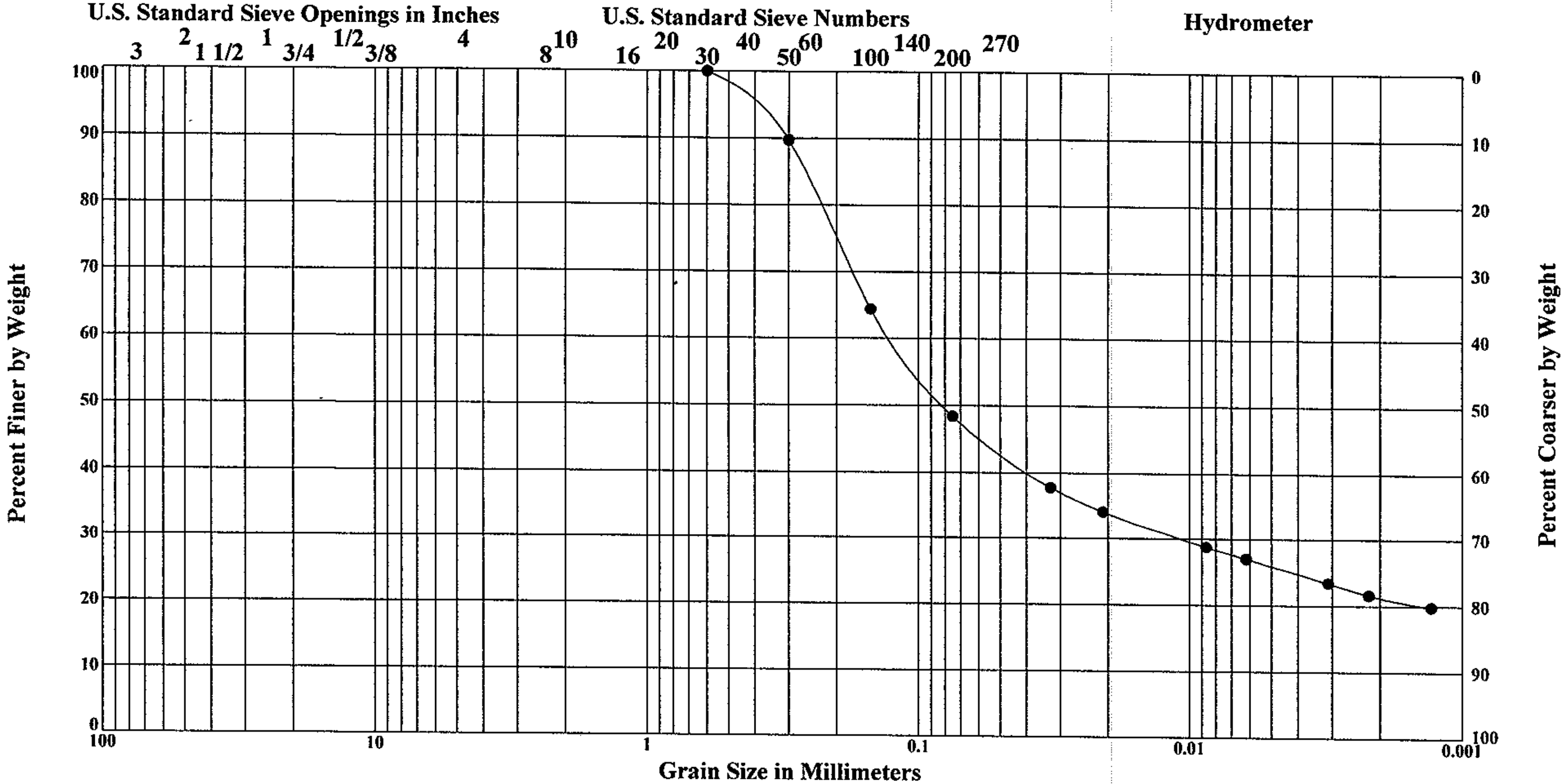

GRAVEL		SAND			SILT or CLAY
Coarse	Fine	Coarse	Medium	Fine	

Grain Size Distribution Curve

Boring No.	Sample Type	Depth	Description	Unified Symbol	Specific Gravity	LL	PL	PI
● B-4	SS-3	8.5-10.0	Light brown CLAYEY SAND	SC	2.65	32	22	10

Proposed Equestrian Campground
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Hutchinson, Kansas

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Project No.: D10G0332

Source:

51.6% Sand 27.1% Silt 21.3% Clay

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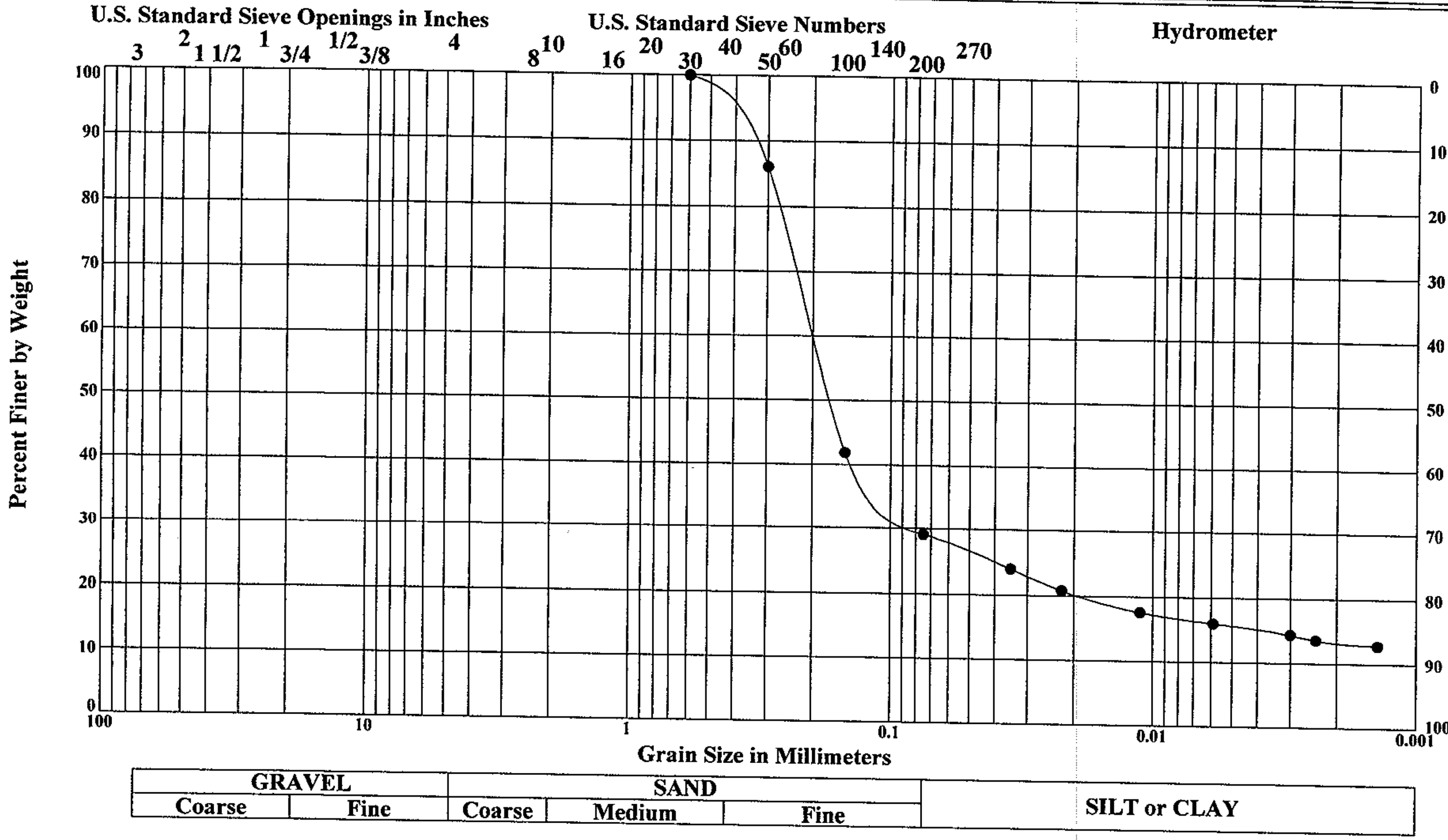

Grain Size Distribution Curve

Boring No.	Sample Type	Depth	Description	Unified Symbol	Specific Gravity	LL	PL	PI
● B-6	SS-1	1.0-2.5	Gray brown fine grained SILTY SAND, trace clay	SM	2.65	NP	NP	NP

Proposed Equestrian Campground
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Hutchinson, Kansas

Approved By: JJZ

Project No.: D10G0332

Source:

70.9% Sand 15.8% Silt 13.3% Clay

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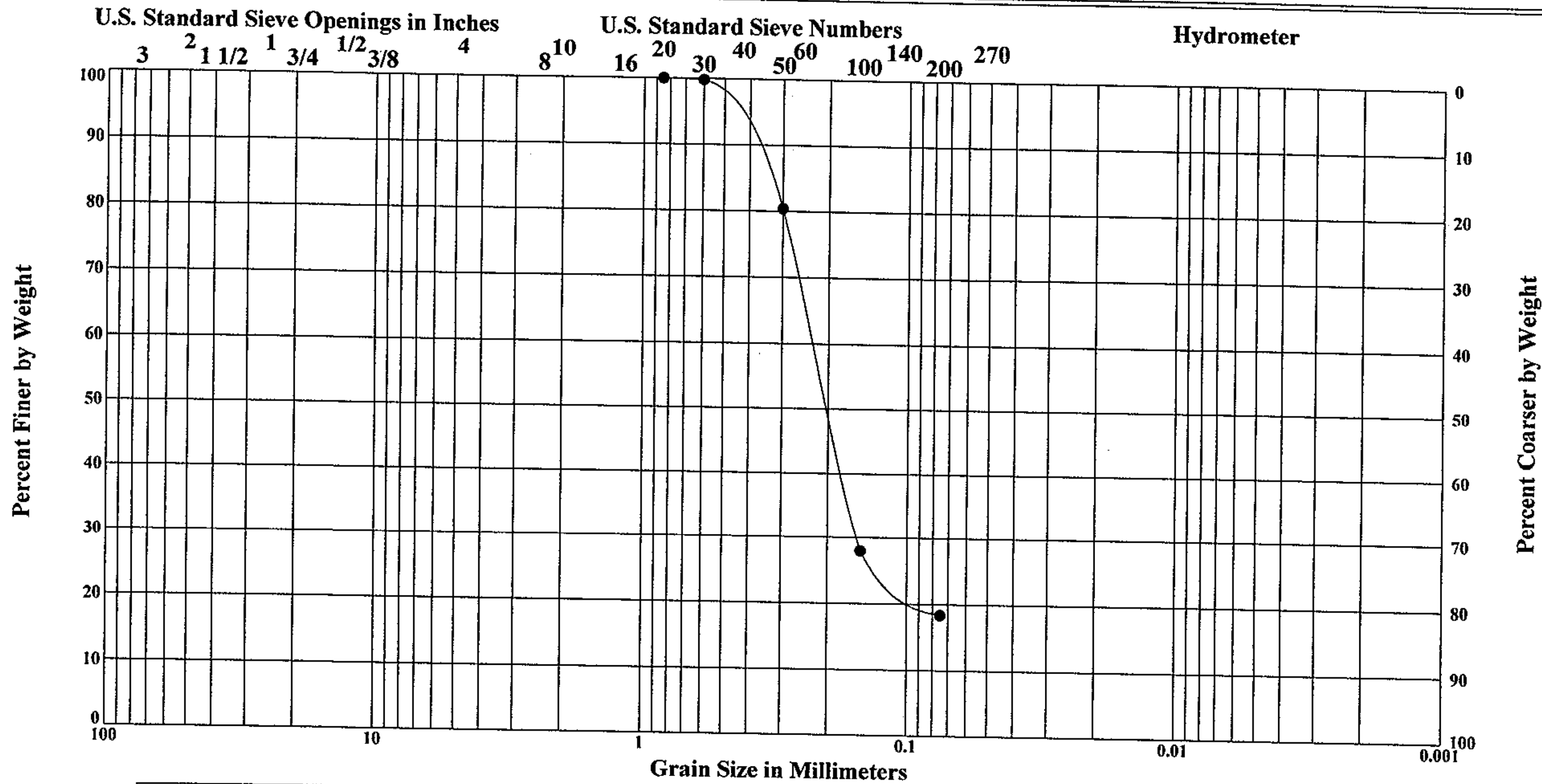

GRAVEL		SAND			SILT or CLAY
Coarse	Fine	Coarse	Medium	Fine	

Grain Size Distribution Curve

Boring	Sample Type	Depth	Description	Unified Symbol	Specific Gravity	LL	PL	PI
● B-6	SS-3	8.5-10.0	Light reddish brown SILTY SAND	SM		NP	NP	NP

Proposed Equestrian Campground

Sand Hills State Park, 4207 E. 56th Street
Hutchinson, Kansas

Approved By: JJZ | Project No.: D10G0332

0.0% Gravel 81.6% Sand 18.4% Fines

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